

Claims

- [001] A multi-layer, bi-axially oriented, thermoplastic film comprising a first outer layer comprising a polyester or a copolyester, a second outer layer comprising an ethylene- or propylene- homo- or co-polymer, a core layer comprising an ethylene-vinyl alcohol copolymer, and no core polyamide or polyester layers, said film having a modulus (evaluated according to ASTM D882) higher than $6,000 \text{ kg/cm}^2$ in at least one direction.
- [002] The multi-layer, biaxially oriented, thermoplastic film of claim 1 wherein the second outer layer comprises an ethylene homo- or polymer.
- [003] The multi-layer, biaxially oriented, thermoplastic film of claims 1 or 2 which is characterised by a modulus higher than $6,500 \text{ kg/cm}^2$ in at least one direction, and preferably higher than $7,000 \text{ kg/cm}^2$ in at least one direction.
- [004] The multi-layer, biaxially oriented, thermoplastic film of any of preceding claims 1 to 3 which is heat-shrinkable and has a total free shrink, at 120°C , of from about 20 to about 140 percent, preferably from about 30 to about 130 percent, more preferably from about 40 to about 120 percent, and still more preferably from about 50 to about 110 percent.
- [005] The multi-layer, biaxially oriented, thermoplastic film of claim 4 which is characterized by a maximum shrink tension in the transverse direction, in the temperature range of from 20 to 180°C , of less than 5 kg/cm^2 , preferably less than 3 kg/cm^2 and more preferably less than 1 kg/cm^2 .
- [006] The multi-layer, biaxially oriented, thermoplastic film of any of preceding claims 1 to 3 which is non heat-shrinkable and heat-set and is characterized by a free shrink at 120°C which is $\leq 10\%$, preferably $\leq 5\%$, more preferably $\leq 3\%$, in each direction.
- [007] The multi-layer, biaxially oriented, thermoplastic film of any of preceding claims 1 to 6 wherein the polyester or copolyester of the first outer layer is a aromatic ring-containing polymer.
- [008] The multi-layer, biaxially oriented thermoplastic film of claim 2 wherein the ethylene homo- and co-polymers of the second outer layer are selected from the group consisting of polyethylene homo-polymers, heterogeneous or homogeneous ethylene- α -olefin copolymers, ethylene-vinyl acetate co-polymers, ethylene-($\text{C}_1\text{-C}_4$)alkyl acrylate or methacrylate co-polymers, ethylene-acrylic acid co-polymers, ethylene-methacrylic acid co-polymers, and blends thereof in any proportion.
- [009] The multi-layer, biaxially oriented, thermoplastic film of any of preceding claims 1 to 8 which has five layers, with a first outer layer comprising a polyester or a

copolyester, a second outer layer comprising an ethylene- or propylene- homo- or co-polymer, a core layer comprising an ethylene-vinyl alcohol copolymer, a first tie layer directly adhering said core gas-barrier layer to the first outer layer and a second tie layer directly adhering said core gas-barrier layer to the second outer layer.

[010] The multi-layer, biaxially oriented, thermoplastic film of any of preceding claims 1 to 8 which has six to eight layers with a first outer layer comprising a polyester or a copolyester, a second outer layer comprising an ethylene- or propylene- homo- or co-polymer, a core layer comprising an ethylene-vinyl alcohol copolymer, a first tie layer directly adhering said core EVOH-containing layer and the first outer layer, a second tie layer between said EVOH-containing layer and the second outer layer and one to three additional core polyolefin layers positioned between the second outer layer and the second tie layer.

[011] The multi-layer, biaxially oriented, thermoplastic film of any of preceding claims 1 to 8 which has seven to ten layers with a first outer layer comprising a polyester or a copolyester, a second outer layer comprising an ethylene- or propylene- homo- or co-polymer, a core layer comprising an ethylene-vinyl alcohol copolymer, a first tie layer between said core EVOH-containing layer and the first outer layer, a second tie layer between said core EVOH-containing layer and the second outer layer, an additional core polyolefin layer positioned between the first tie layer and the first outer layer, a third tie layer directly adhering said additional core polyolefin layer to the first outer layer and optionally one to three additional core polyolefin layers positioned between the second outer layer and the second tie layer.

[012] The multi-layer, biaxially oriented, thermoplastic film of any of preceding claims 1 to 11 which comprises anti-fog agents or compositions in the second outer layer or/and in any polyolefin core layer possibly positioned between said second outer layer and the EVOH-containing layer.

[013] The multi-layer, biaxially oriented, thermoplastic film of any of the preceding claims 1 to 12 which is irradiated to a level of from about 10 to about 200 kGy, preferably of from about 15 to about 150 kGy, and more preferably of from about 20 to about 120 kGy.

[014] A process for the manufacture of a bi-axially oriented, thermoplastic film comprising a first outer layer comprising a polyester or a copolyester, a second outer layer comprising an ethylene- or propylene- homo- or co-polymer, a core layer comprising an ethylene-vinyl alcohol copolymer, and no core polyamide or polyester layers, said film having a modulus higher than $6,000 \text{ kg/cm}^2$ in at least one direction, which process comprises co-extruding the film resins through a

flat die and bi-axial orientating the obtained cast sheet simultaneously in the two perpendicular directions at an orientation ratio in the longitudinal direction higher than 2:1, preferably higher than 3:1, and at an orientation ratio in the cross-wise direction higher than 2:1, preferably higher than 3:1, by means of a tenter frame, said process being optionally followed by an annealing or heat-setting step.